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Early Chemical Control of Weeds in Europe¹

ALLAN E. SMITH and D. M. SECOY²

ABSTRACT. A brief history of chemical weed control in Europe from ancient Greek and Roman times to 1850 is given. The use of the various chemicals recorded is discussed and their possible efficacy commented upon.

INTRODUCTION

"But to me it seems the mark of a very poor farmer to allow grass to grow among his crops, for it detracts greatly from the yield if weeding is neglected." Columella, *De Re Rustica*, II, XI, 6.

The harmful effects of weeds were known to early historic man as shown by remains of hoes and grubbing implements and also by references in ancient literature. An illustration of the latter is the above quotation (10) from the work of a Roman writer and agriculturalist in the first century A.D. Nearly all books on agriculture, horticulture, or crop husbandry written from the time of Theophrastus (34) until modern times have mentioned the universal problem of weeds and their deleterious effects, even though empirical data on weed-crop competition were not available until the work of Jethro Tull during the first half of the eighteenth century (37).

Weeds have been controlled in most societies, at first by hand and later by various mechanical devices. Chemical weed control is considered to be of recent origin, dating from the last decade of the nineteenth century. However, a survey of early literature indicates that from earliest recorded times agriculturalists appear to have used naturally occurring substances and simple manufactured chemicals for the control of unwanted plants in croplands, orchards, vineyards, and gardens.

The purpose of this review is to discuss in some detail the various products and chemicals used for weed control from classical Mediterranean times until the middle of the nineteenth century and the advent of the modern herbicide industry. This review may also be considered to supplement the article by Timmons (35) in which the history of weed control, chiefly in relation to the United States and Canada, was discussed.

DISCUSSION and REVIEW of LITERATURE

The ancient Mediterranean farmers were plagued by a variety of unwanted plants, many of which were mentioned by name by the classical authors (33) and are identical or similar to species considered weeds by modern farmers. The Latin words

herba and *herba inutilis* seem to have been used to denote unwanted grasses and plants and so may be taken as general terms for "weeds". It is probably true that during the classical era the majority of weeding was carried out manually or by the use of hoes (*raster* and *sarculus*), the plough, or the sickle. Virgil, during the first century B.C., mentioned the practice of burning the cereal stubble following the harvest, which may have resulted in the destruction of many weed seeds (33).

In the fourth century B.C. Theophrastus (34) recorded that trees, especially young ones, could be killed by pouring oil (presumably olive oil) over their roots. Olive oil, pitch, and grease were also noted by Pliny in the first century A.D. as being harmful to seeds (31), but there is no specific reference to their use for the destruction of weeds.

Pliny also referred (31) to the Greek Democritus (fifth century B.C.), who had proposed that forests could be cleared by sprinkling the tree roots with the juice of hemlock in which lupin flowers had been soaked. Lupin seeds and hemlock juice contain alkaloids and these compounds in hemlock, which include coniine, are toxic to humans. This was known to the ancient Greeks, who used hemlock juice in judicial executions, such as the forced suicide of Socrates in 399 B.C. There is no evidence that hemlock and lupin extracts would have any harmful effect on trees, but ancient man often made the assumption that a substance harmful to one organism would be harmful to others.

An agricultural product described by nearly all of the Roman writers was amurca, the watery residue obtained after the oil was drained from crushed olives. Amurca had many uses such as a seed steep, a preventer of plant disease, and an insect deterrent (33). This generally used product was also advocated for weed control. Both Cato and Varro (9), writing during the first century B.C., recommended that threshing floors be constructed from earth and amurca to prevent weed growth. This practice was mentioned by subsequent Roman authors. Since Cato (9) also described how amurca, straw, and soil could be made into a plaster or stucco one must assume that the threshing floors constructed in the above manner were impervious to weeds rather than toxic to them. However, a reference by Varro (9) specifically stated that amurca was poisonous to weeds, ants, and moles and he further described that where the amurca flowed from the olive presses onto the fields the ground became barren and so "...it is usually poured around the roots of trees, chiefly olive trees, and wherever noxious weeds grow in the fields."

The latter seems to be the earliest surviving reference to the use of a preparation for the specific killing of weeds and is given only by Varro. It has been suggested by Smith and Secoy

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(33) that amurca would be a watery fluid containing a complex mixture of the easily hydrolisable bitter glycoside oluropine, together with traces of phytocidal glyceride oils. A further complicating factor is that in some districts salt was added to the olives prior to pressing and thus the salt could have been the phytocidal agent.

Salt and sea water were known to be harmful to plants, as references by the writers Xenophon (40), Virgil (38) and Palladius (fourth century A.D.) (27) imply. Application of salt to the fields of enemies was often used as a means of punishment, and in 146 B.C., following the sack of Carthage, the Romans sowed salt into the ground to prevent the growing of crops. Although the phytotoxic properties of salt seemed to have been understood since the earliest times, the authors can find no mention of its specific use for the killing of unwanted plants during the classical era.

Over the thousand years following the conquest of Rome in 460 A.D., references to chemicals detrimental to, or used for the killing of weeds are few and chiefly from Arab sources. Phytocidal effects of salt are referred to in the *Geoponika* (8), a work compiled from many sources by Cassianus Bassus during the sixth or seventh century. Mixtures of duck excrement and salt were held by Ibn Qutayba in his ninth century encyclopedia to kill vegetable crops, while the fourteenth century work of Nuwairi stated that a mixture of herbs and salt would destroy "desirable and undesirable" plants (26). Albertus Magnus (1193–1280) in his *De Vegetabilibus* (1) also mentioned the harmfulness of salty soil to most plants. The toxic effect of animal excrement on plants seems to have been suggested during this period. In the *Geoponika* (8) a method is given for preparing human feces so that they would kill weeds. The twelfth century Arab agricultural writer Ibn-Al-Awam (21) described the harmful effects of excrements and also remarked that human feces destroyed unwanted plants in seed beds. In the recipe by Ibn Qutayba mentioned previously, the duck excrement was considered as harmful as the salt.

With the invention of printing during the latter half of the fifteenth century the agricultural works of Cato, Columella, Palladius, and Varro were collectively published as *Scriptores Rei Rusticae*, the first edition appearing in Venice in 1472. This work was reprinted many times over the next 100 years and subsequently translated into modern European languages so that the classical agricultural knowledge became available to the literate of the period. However, none of the early English writers on agriculture such as Thomas Hill (18), author of *Gardener's Labyrinth* in 1586, or Barnaby Googe (16), who in 1586 translated the *Four Bookes of Husbandrie* of Conrad Heresbach from the German, make any mention of amurca, salt, or any other compound being used for the killing of weeds. This is especially interesting because they make numerous references to material from the *Scriptores Rei Rusticae*.

In 1594 salt appears to have been in use as a weed killer in England, since Hugh Plat recommended that if two bushels of bay salt were mixed with four bushels of winter grain prior to sowing, then not only would a greater yield be obtained, but the land would be improved "and cleared of weeds" (30). In 1620 Gervase Markham wrote that salt should be used to kill weeds in grain and pulse crops as "there is nothing which

killesh weedes, quicks, and other offences of the ground so much as saltness" (25). During the last quarter of the seventeenth century John Worlidge (39) and John Evelyn (15) discussed the use of salt to kill weeds in gravel walks and paths. From extant literature it is apparent that farmers and agriculturalists gradually learned how to use salt as a selective weed killer by experimenting with application rates and the timing of such treatments. Thus, in 1733 an anonymous author could describe (3) the practice in Scotland of sowing ten or twelve bushels of salt to an acre of wheat in the fall. This application killed all the weeds, but not the winter wheat. The author cautioned careful use of the salt since an excess would destroy both the weeds and the wheat. In the early nineteenth century John Hollingshead (20) suggested that salt at a rate of forty bushels to an acre could be used on fallow land in the fall. This rate would kill all the weeds, but over the winter, spring, and summer the salt would be "dissipated" so that cereals could be sown the following fall. Pamphlets on the subject of salt written by Cuthbert Johnson (22, 23) and Samuel Parkes (28) during the early nineteenth century also mention the killing of weeds as one of the most important agricultural uses of salt.

Salt was advocated for the killing of perennial weeds, specifically dwarf thistles (*Carduus* spp.) by Benjamin Holdich in 1825. Instead of the salt being broadcast over the land, it was to be dropped onto the crown of the individual plants, which effectively destroyed them without injury to grass crops. Children were to be employed to apply the salt by hand to the weeds (19). It was also reported in the *Farmer's Journal and Agricultural Advertiser* of 18 December 1826 that salt could be used to destroy thistles (*Carduus acaulis* L.) and other plants of similar form such as *Plantago*, *Leontodon*, *Rumex*, etc. The salt was applied to the crown or central leaves and ground into the plant with the heel. This was supposed to kill the leaves and effect decay of the root. The *Journal* also stated that salt similarly applied to plants where the stems had been cut flush with the ground would have the same effect.

The salt used in English agriculture was obtained either from the old salt pits of Cheshire or by evaporation of sea water to produce bay salt. The sea water was not evaporated to dryness but only to the point at which crystals formed; the salt crystals were then removed leaving behind a solution of calcium and magnesium salts known as "bittern" (7). John Worlidge in 1683 mentioned the killing of weeds in gravel paths and walks by the application of bittern, which he reported as "absolutely destroying" all vegetation (39). This, however, seems to be the only reference to the use of bittern being used phytotoxically, so perhaps its use was not general.

Soot was advocated from Roman times as a treatment against insects, snails, slugs, and worms. Its use against moss was cited by both Moses Cook (11) in 1676 and by Edward Lisle in 1757 (24). Thereafter, no further reference to soot for this particular problem seems to have been made. Also, it is not clear whether the soot to be used for moss removal was that derived from wood, coal, or both.

John Trussler in 1785 mentioned (36) that thistles in grass lands could be destroyed by applying soap boiler's ashes to the mowed plants. The ashes used in the manufacture of soap were

alkaline, containing appreciable amounts of lye or potassium carbonate.

William Ellis in 1742 averred (14) that thistles could be eradicated from his land by following deep ploughing with chalking. In fact, Ellis thought that this combination was successful against most weeds infesting his lands. However, Ellis seems to have been a lone figure in the use of chalk for the control of weeds.

Lime had been used since the classical era as an insecticide and since the end of the sixteenth century as a fungicidal compound, but its herbicidal usage was not mentioned until 1811 when Brodie remarked (5) that heath plants and certain other plants could be killed by soil applications of lime.

Copperas or green vitriol (ferrous sulphate) was used in agriculture from the early eighteenth century as an additive to seed steepers to help control "smuts" or to prevent the seed from being attacked by worms and insect larvae (6). Iron salts had long been known to be harmful to vegetation, and Pliny wrote (31) that it was bad for rue, savory, mint, or basil to come into contact with iron. Thomas Hale in 1759 agreed that iron salts were harmful to vegetation (17) and cited instances of poor crop yield in the vicinity of waters or soils containing iron deposits.

In Loudon's *Gardeners Magazine* of 1826 (2), the editor wrote that in France copperas was considered to be poisonous to plants, so much so, that supposedly the roots of weeds could be killed by mowing with a scythe whose blade had been sharpened on a stone previously dipped in ferrous sulphate solution. A similar statement is to be found in the writings of de Candolle (12) in 1832. The editor of Loudon's *Magazine* commented on this usage of copperas as follows:—

"We notice this as a specimen of absurdity founded in fact. If weeds may be so killed then ground may be manured by being dug with a spade stuck every now and then in a dung hill" (2). Notwithstanding this acerbic comment one is left with the impression that in France copperas was being used as a herbicide at least as early as 1825.

The final chemical to be considered is blue vitriol or blue stone (copper sulphate). Copper sulphate was introduced agriculturally in 1761 by Schulthess as an additive to seed steepers for the control of "smuts" (6), but during the next few years it was discovered that prolonged treatment of grain with the copper salt resulted in reduced germination. The phytotoxic effects of copper salts were further demonstrated by de Saussure in 1804 (13); he showed that plants grown in a solution of copper sulphate died within a few days as a result of root destruction. However, these scientific studies of de Saussure did not result in copper sulphate being used as a weed killer, neither did two further reports of its phytocidal use published in 1821. One by Phillips told of copper salts (29) poured near the roots of a young poplar tree resulting in the death of the tree, while the second, by John Barclay in Scotland, reported (4) that by carefully adjusting the amount of copper sulphate in his seed steep he could selectively destroy the germinating properties of seeds of the weed pappale (*Agrostema githago* L.) contaminating his wheat seed without unduly affecting the germinating quality of the wheat. Further experimentation by

Barclay showed that seeds of common field vetch (*Vicia sativa* L.) could be similarly destroyed. Extreme caution in the use of copper sulphate steepers was urged by Barclay lest the development of the wheat be severely retarded. This fine line between destruction of weed and grain may have been one of the reasons for the failure of this method to attract the attention of the ordinary farmer.

It is seen that chemical weed control was advocated from the earliest classical times although we do not know how extensively such practices were carried out. The only phytotoxic chemical seemingly carried over from classical antiquity was salt and it is interesting to speculate that perhaps it was continuously used for weed control from the classical era. Since the late sixteenth century the development of salt usage from a general killer of unwanted weeds in garden walks to its selective use for removal of weeds from crops, summerfallow, and perennial weeds in grasses shows an increasing sophistication.

Other compounds used as weedkillers such as bittern, soot, soap boiler's ashes, and chalk have not stood the test of time and it is doubtful if they were ever very effective or widely used. Lime would have been useful for the purposes described, since by making the soil more alkaline the suppression of plant species adapted to more acidic soils would be achieved.

Copper and iron sulphate have been known since the middle of the eighteenth century to be harmful to vegetation but no real attempts seem to have been made to use them for the selective killing of weeds, and their use was restricted to additives of seed steepers, mainly for the control of "smut". Sulphuric acid was also in general use as an agricultural chemical from about 1800, as both seed steep additive and for the destruction of insects in cultivated land. However, over a hundred years would lapse before Bonnet (1896) showed that a solution of copper sulphate could kill charlock plants infesting cereals. This observation, together with the discovery by Martin and Duclos (1897) that solutions of ferrous sulphate and sulphuric acid could be used for the same purpose, heralded the modern era of weed control (32).

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